LAB: Linear Alkyl Benzene

Detergent linear alkylbenzene (LAB) is manufactured using linear hydrocarbons in the C_{10} – C_{13} range. All LAB contain alkyl side chains of 10, 11, 12, and 13 carbons in length. Average chain lengths of LAB range from 11.3 to 11.8 carbons. Depending on the catalyst used in making LAB, the positional isomer distribution, commonly referred to as the 2-phenyl isomer content, varies significantly.

Methods of Manufacture

- **Olefin/HF** – Olefins (derived from linear paraffins) are reacted with benzene in the presence of HF (hydrofluoric acid) catalyst in preparing the LAB. The alkylate is low in 2-phenyl isomer (12 – 22%).

- **Olefin/AlCl_{3}** – Olefins (derived from linear paraffins) are reacted with benzene in the presence of AlCl_{3} catalyst in preparing the LAB. The alkylate is high in 2-phenyl isomer content (25 – 35%).

- **Olefin/ Solid Catalyst** - Olefins (derived from linear paraffins) are reacted with benzene in the presence of solid catalyst in preparing the LAB. The alkylate is high in 2-phenyl isomer content (25 – 35%).

Effects on Performance

- **Average Chain Length** – As the average chain length increases, the water solubility decreases. C_{11.3} LAB is better for light duty applications. C_{12.8} LAB has better detergency, and is used in heavy duty applications, e.g. home laundry formulations.

- **High 2-Phenyl** – Same as “B’ but with very slightly higher viscosity.

- **Low 2-Phenyl** – Good for formulations where decreased water solubility is desired or for heavy duty I & I applications.

LAS: Linear Alkylbenzene Sulfonic Acid

Reacting LAB with oleum or sulfur trioxide produces linear alkylbenzene sulfonic acid.

Pilot’s Methods of Manufacture

- **SO_{3}/SO_{2} Continuous Process**: In Pilot’s unique, patented Ice-Cold Sulfonation process, LAB is sulfonated by reaction with SO_{3} (sulfur trioxide) in the presence of SO_{2} (sulfur dioxide). The SO_{2} acts as both a refrigerator and diluent to moderate the sulfonation reaction. The SO_{2} is removed after the sulfonation is complete.

- **Continuous Air/ SO_{3} Sulfonation**: LAB is sulfonated by reaction with SO_{3} (sulfur trioxide) in the presence of a stream of dry air. The airflow is controlled to maintain the proper air/SO_{3} ratio and to moderate the reaction temperature.
Pilot’s LAS Type Products

B. **High 2-Phenyl**: Calsoft® LAS-99, Calsoft® F-90, Calsoft® L-60, Calsoft® L-50, and Calsoft® L-40 where the end products have good water solubility, form clear solutions and can easily build viscosity.

C. **Low 2-Phenyl**: Calsoft® LPS-99 and Calsoft® P-85. The end use products have lower water solubility, do not form clear solution at the 30% level, and are used for heavy-duty applications where oily soil removal is enhanced.

Neutralization

LAS is neutralized by adding sulfonic acid into a caustic solution while mixing. Good mixing is required to adequately disperse and neutralize the LAS. In preparing 1000 lbs. of 60% NaLAS, water (~300 lbs.) and 50% NaOH (~150 lbs.) are mixed together in preparing a 17% NaOH solution. LAS-99 (~550 lbs.) is slowly added into the caustic solution in a stainless steel vessel while mixing. The final product’s pH should be in the 7.0 – 8.5 range. If the pH drops below 7.0, high levels of iron can be introduced into the NaLAS product causing the material to take on an orange colored appearance. On dilution or blending with other surfactants at reduced concentrations, the iron salts tend to fall out of solution forming an orange precipitate. At very low pH values in the 2 – 5 range, the NaLAS solution will have a pungent sulfide odor because of corrosion of iron or steel. More information can be found in Pilot’s technical bulletin “Calsoft® LAS-99 Neutralization Procedure”.

Composition:

Pilot’s Calsoft® LAS-99 and LPS-99 are high in active (97% minimum) and low in free oil and sulfuric acid (typically <1.5% each). The sulfonic acid color is low, less than 25 Klett (40mm, 5% soln.).

Applications:

A. **Neutral Salts**: The sodium, calcium, potassium, ammonium, diethanolamine triethanolamine, and mono isopropylamine salts can be prepared from LAS-99, LPS-99, or TSA-99.

B. **Laundry Detergents**: LAS is most often used in combination with other surfactants such as alcohol sulfate, alcohol ether sulfate, alcohol ethoxylate, or soap. Mixed active products provide greater versatility with respect to washing conditions. The addition of alcohol ethoxylate and/or fatty acid soap also helps limit foaming. This is important in front-loading washers and industrial cleaning equipment.

C. **Hand-Dishwashing**: LAS is commonly used in combination with alcohol ether sulfate (AES). Both LAS and AES are excellent foamers, but blends (particularly in the 4:1 LAS: AES range), provide more stable, soil-tolerant foam. Consequently, most hand dishwashing detergents that contain LAS also contain AES.

D. **Hard-Surface Cleaners**: LAS is used when foaming, particulate detergency and powder properties are important.

E. **Shampoos or Liquid Hand Soaps**: LAS is not normally used because LAS may be somewhat harsh at the high surfactant concentrations typical of these types of products.